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CONSULTANT GROUP ON ATOMIC ENERGY
IN RELATION TO MEDICINE AND PUBLIC HEALTH

14 December 1954

SUMMARY NOTES OF THE FOURTH MEETING

Palais des Nations, Geneva
Tuesday, 14 December 1954, at 2.15 p.m.

CHAIRMAN: Dr. Bucher

CONTENTS

1. TRANSPORT OF RADIO-ACTIVE MATERIALS

The CHAIRMAN indicated that a very important point was the transport of critical material required for atomic energy programmes: these included uranium, plutonium, and uranium metal which constituted a fire risk in view of its high degree of inflammability. The transport between countries of radio-active isotopes was also very important.

Dr. TIMMERMAN said that WHO had taken up the question of the transport of goods between countries in connexion with complaints that medical research workers were not receiving pathological strains or live animals ordered, which in some cases were held by customs authorities until they were dead. The matter was still under discussion and the Universal Postal Union (UPU) was collecting information on the legal requirements in different countries on behalf of WHO. He felt, however, that one reason for the difficulties which had arisen was that persons ordering strains or experimental animals did not know the regulations in their own countries. The final aim, however, was to achieve international unification of regulations.

Dr. BRAVO said that in August 1953 the Inland Transport Committee of the Economic Commission for Europe had considered a list of goods dangerous in transport and had included among them radio-active substances.

The CHAIRMAN thought that the real problem lay in determining standards for the regulation of the external activity of radio-active material packed for transport. In the USA for the time being materials which could be placed next to photographic film for, say, 12 hours, were acceptable by most air lines. Such a requirement was of course well within the limits of safety to a person's health.

Dr. LOUTIT said that in the United Kingdom radio-active materials could not be sent by post but could go by common carrier provided they were suitably labelled and the dose of radiation was clearly stated.

Dr. CIPRIANI felt that two aspects had to be considered in the transport of radio-active materials. The first was the safety distance from a proper container for such materials, and the second was the question of accidents by road or by rail. Canada was at present drafting regulations for road transport in particular, patterned on those of the United Kingdom. He added that, although an attempt had been made, no international agreement had been reached on ~~the subject~~ transport regulations.

Dr. LOUTIT added that one difficulty regarding photographic film was that its manufacturers generally disliked labelling their parcels as photographic film. Such parcels might therefore unwittingly be placed next to radio-active material.

The CHAIRMAN thought that film manufacturers were on the whole accepting the necessity to label film as such.

A greater difficulty was to ensure that there was sufficient co-ordination or uniformity of regulations to ensure that radio-active materials were transported between countries with the least possible obstruction, particularly since such transport would increase considerably within the next few years.

The DEPUTY DIRECTOR-GENERAL thought that WHO might do well to draw attention to that aspect of the problem and to the difficulties that would be created by delays, unforeseen circumstances, and accidents. WHO would also be willing to consider the health problems thus presented in any

international discussion. He felt that the proposed international conference on peaceful uses for atomic energy might be particularly appropriate for that.

2. RADIOLOGICAL UNITS AND STANDARDIZATION OF MEASURES

The CHAIRMAN said that the question of the standardization of measures of radiation had been considered for some years but was still not satisfactorily answered.

Dr. LOUTIT thought the problem to be one largely of academic physics. Measurement of the degree of disintegration of an atom and of the resulting dosage of radiation was still not ~~a hundred per cent.~~ 100% accurate but depended on continuing physical research. Atomic energy workers at Oak Ridge and at Harwell were exchanging information and were trying to approach some common practice.

Dr. CIPRIANI agreed with Dr. Loutit; as techniques improved it would be possible to get closer to absolute measures and to common practice. In biological work it was possible to purchase international standards, but the difficulty was in using them correctly; that could be overcome by providing adequate instructions with them.

Radiation units had been considered by the ~~International~~ on Radiological Protection Commission which had proposed measurement in ergs per gram. Unfortunately it was not known how to measure those.

After some further disucssion, the DEPUTY DIRECTOR-GENERAL said that it seemed clear that it was necessary for some body to assume responsibility

for the co-ordination and dissemination of information and techniques; it was, however, still too early to say what body that should be. That would become clear when more was known of the proposed International Atomic Energy Agency. However, it was the duty of WHO to say that it might be able to help in the collection and dissemination collation of information.

Dr. GEAR added that the question of standardization of measures also concerned the granting of fellowships. Fellows having studied abroad should know something of the matter on return to their countries.

Dr. CIPRIANI said that a question of technique which raised considerable difficulty was that of measuring the irradiation to which human beings had might have been subject to.

The CHAIRMAN agreed and added that while biologists generally measured such irradiation in terms of ~~ionition~~ ionization there were some levels of energy at which ~~ionition~~ ionization might play only a minor part. Better methods would have to be found before measuring at such levels.

Dr. CIPRIANI pointed out that in order to determine the effect of radiation on human beings it was necessary to be absolutely certain of the underlying dosimetry. The bigger hospitals would therefore find it absolutely necessary to add physicists to their staff when dealing with radio-active isotopes.

3. MEDICAL THERAPY

The CHAIRMAN said that radio-active isotopes had been used in treatment for many years, but the number and variety in use had recently increased. They were usually used as palliatives.

Dr. LOUTIT said that the three main radio-active substances used in therapy in the United Kingdom were iodine, phosphorus and gold. Work with them was confined to certain centres and to certain groups of cases for clinical trials on a restricted number of diseases, particularly those concerned with the thyroid glands or with carcinoma. Attention was being directed more towards improving the techniques for administering isotopes than to achieving spectacular results.

Dr. CIPRIANI said that one problem was to prevent the administration of isotopes by the wrong persons. In Canada isotopes were sent not to doctors but to institutions which were responsible for their use by the doctors. This, however, led to some difficulties with the medical profession.

He felt that there was a very fruitful field for research in experimenting with treatment by isotopes to determine in some measure what elements had what effect on the human person.

The CHAIRMAN added that another problem meriting study was that of the use and usefulness of the half-life isotope.

There was also the problem of the use of isotopes in mass as sources of radiation. There was, for instance, a mechanism using cobalt 60 which could replace high voltage X-ray machines to advantage since its future performance was predictable and since it was easier to handle.

Dr. GEAR asked whether such a machine was of the kind that could be satisfactorily used in under-developed countries.

The DEPUTY DIRECTOR-GENERAL added that while WHO had a constitutional duty of stimulation it also had the moral obligation to act as a restraining influence under certain conditions.

The CHAIRMAN said that ~~it~~ the cobalt 60 machine required as much skill to use as the ordinary high voltage X-ray machine but that it could be used in clinics remote from X-ray maintenance services.

Dr. LOUTIT felt that under-developed countries should be encouraged to send persons abroad to seek the requisite training to handle such machines.

4. MEDICAL DIAGNOSIS

Dr. LOUTIT said that there was a great variety of possible uses of radio-active materials for diagnostic purposes. However, he felt that too enthusiastic a resort to such materials would result in their increased dissemination among the population at a time when there was still too much doubt ~~of~~ as to their influence on genetics. In the United Kingdom there were a few accepted diagnostic tests using radio-active material, but the emphasis was on research.

Dr. CIPRIANI agreed that tracers should not be used on patients for diagnosis unless it was really necessary. However, there was a place for their use in the study of human physiology.

The CHAIRMAN said that ~~there was~~ rapidly developing research in the USA on the diagnostic and physiological use of radio-active material ~~which~~ was leading, for instance, to promising tests of liver function and to new methods for estimating metabolic activity. There were also applications in veterinary medicine.

5. AGRICULTURAL APPLICATION OF RADIO-ACTIVE MATERIAL

The CHAIRMAN said that much more information was needed on molecular movement in soils and on the intake by plants through their roots and leaves. The use of radio-active material could be very wide in that respect. For instance, phosphorus 32 had been tagged to fertilizers in experiments in the USA and in Canada and had shown that individual crops required different methods of fertilization for the maximum fertilization or value to be derived. He thought that little comparable work had been done in tropical countries.

Prof. MANNEBACK said that there was a fairly richly endowed institution for the study of tropical plants in the Belgian Congo, and he felt its staff and the staff of similar institutions should be trained in the new tracer techniques before they were sent out. It was very difficult and very expensive to recall them later in their careers.

Dr. DEROLLE wondered whether radio-active materials could be used to study the distribution of nutrients in animals.

The CHAIRMAN agreed that not only that could be done but that it had the added advantage that there would be no disturbances to the system.

The meeting adjourned at 4.25 p.m.
and was resumed at 4.35 p.m.

6. MARINE BIOLOGY

Dr. LOUTIT said that the Ministry of Fisheries of the United Kingdom had undertaken a programme of research into the movement of fish in connexion with the Cumberland atomic energy project. Fish had been traced for several seasons and it had been found that the adult fish spent no more than a few months in the coastal areas and were therefore only periodically exposed to contaminated effluent. The highest concentration of activity was received by the spawn and fry, ~~and~~ which might be expected to be the most sensitive to it. However, the limits imposed on the Cumberland establishment had been such that there had so far been no contamination ~~in~~ of fish or ~~plant~~ spawn.

While there had been no apprehension as regards fish, there had been some concerning the sea-weed collected in that part of England for shipment to South Wales as an ingredient of laverbread. It had, however, been found that the concentration of radio-activity after dilution in sea water had not been high enough to make that sea-weed a dangerous food to man.

Laboratory experiments conducted by the Ministry of Fisheries had shown that plaice kept in a tank contaminated with radio-active materials took a year to accumulate in their muscle 5-10 times the amount of radio-activity in the ambient water and very nearly as long to lose it when they were put in fresh water again. Experiments with sea-weed had shown that the radio-active materials were only taken up when the sea-weed was exposed to light.

Dr. CIPRIANI said that fish collected in the Ottawa River near the Chalk River ~~approach~~ project had shown a slight degree of radio-activity which gave

no cause for alarm. He thought that there might be very wide application of the use of radio-active materials in marine biology, a branch of scientific study which badly needed new tools.

The CHAIRMAN said that in the United States of America, as well, studies and experiments were being carried out on fish, particularly salmon and the Atlantic tunny. The Pacific tunny was being studied in Hawaii.

7. EPIDEMIOLOGY AND THE MOVEMENT OF POPULATION

The DEPUTY DIRECTOR-GENERAL ~~wondered whether~~ would that an important aspect was the possible use of radio-active material ~~could be used~~ to study animal- or insect-borne diseases and the problem of parasites, ~~Might it~~, for instance, ~~have an application to~~ in epidemiological studies of sylvatic plague? etc.

Dr. CIPRIANI said that in Canada studies with radio-active material had been carried out on, among others, the pine weevil, grasshoppers and mosquito larvae. Indeed, the only limit to the use of radio-active material seemed to be the imagination of man.

Dr. TIMMERMAN asked whether the use of radio-active material might alter animal behaviour.

Dr. CIPRIANI answered that it might, but that insects seemed to be able to absorb large quantities without harm and that the tracers used were, of course, minute in quantity.

Dr. LOUTIT said that the point raised by Dr. Timmerman was most important. Much early work on the intake of phosphorus by plants had been invalidated by damage to their root systems.

Dr. GEAR said that the question of the use of radio-active material in epidemiological work was very important to WHO, one of whose functions was to encourage investigations which could be assisted by international co-operation. New tools to study the movements of insects, animals, and even humans, might prove of great value.

8. MEDICAL REACTORS

The CHAIRMAN said that reactors had originally been of interest to physicists and atomic engineers and had not been designed with the interests of biologists in mind. However, there was now a need for them as simple and reliable sources of radiation, and some work had been done in that connexion in the United States of America.

Dr. LOUTIT thought that the occasions on which a biologist could work on the normal present-day reactor with the physicist and the engineer were rare, but wondered whether some pooling of resources might be achieved in Europe for biological research, using small atomic reactors for research purposes.

The DEPUTY DIRECTOR-GENERAL thought that the point raised by Dr. Loutit might well be of interest to certain Regional intergovernmental organizations, such as the Council of Europe, which had already undertaken the pooling of other resources.

9. RADIATION AND PLANT GENETICS

The CHAIRMAN said that radiation had first been used in the field of genetics in connexion with mutations of the fruit-fly. Since then,

outstanding results had been obtained by irradiating both plant seeds and the growing plant. Thus, oat seeds had been irradiated to produce a rust-resistant mutant and maize had been irradiated in the field with cobalt 60 to produce a new strain giving a greater yield per acre on a shorter plant. Principles that applied in the vegetable kingdom probably held true in the animal kingdom as well, although not so much work had been done on animals.

The DEPUTY DIRECTOR-GENERAL wondered whether any experiments had been carried out on the mutation of viruses by radio-active irradiation.

The CHAIRMAN answered that while most attention had been given to work on the bacteriophages, attempts had also been made to produce variants of influenza viruses with the intention of producing a more potent vaccine.

Dr. LOUTIT said that so far as he knew, the production of mutant types of plants for commercial use, such as the Chairman had mentioned, had not been tried on any scale in Europe.

Dr. CIPRIANI said that another interesting application of radiation was in embryology, to arrest the development of certain parts of the embryo. Conversely, attention had to be paid in pre-natal care not to subject human beings to unnecessary irradiation.

Dr. LOUTIT added that there was a certain radiation risk in some occupatio for instance, radiographers in the United Kingdom were frequently young women

who continued to work well into their fifth month of pregnancy and were subjected to irradiation at the most dangerous period.

The meeting rose at 6.05 p.m.

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CONSULTANT GROUP ON ATOMIC ENERGY
IN RELATION TO MEDICINE AND PUBLIC HEALTH

14 December 1954

SUMMARY NOTES OF THE THIRD MEETING

Palais des Nations, Geneva
Tuesday, 14 December 1954, at 9.30 a.m.

CHAIRMAN: Dr. Bugher

CONTENTS

1. STATEMENT BY THE DEPUTY DIRECTOR-GENERAL

Dr. DUROLLE, Deputy Director-General, said that he wished, on behalf of the Director-General, to reassure members of the Group that their answers to the question about possibilities for placing fellows in their countries and about other facilities would be regarded as purely informative and in no way committing their governments.

2. ORDER OF DISCUSSION

The CHAIRMAN said that after the general discussion at the two previous meetings the Group had drawn up a list of points which it would like to discuss before returning to the tentative agenda.

Dr. DUROLLE, Deputy Director-General, said that that procedure would be perfectly feasible. Those responsible for drawing up the tentative agenda had fully expected that the Group would wish to adopt a more pragmatic approach to some of the problems before it.

The CHAIRMAN proposed that the Group should first take up certain negative aspects of atomic energy problems and notably the question of protection against injury.

3. PROTECTION AGAINST INJURY FROM RADIATION OR RADIOACTIVE MATERIALS

The CHAIRMAN said that, as indicated at the previous meeting, the International Commission on Radiological Protection assembled all the available data so as to decide on margins of safety, taking into account age and length

of exposure as well as the fact that persons working in atomic energy establishments were there voluntarily and for a limited period of time, whereas people living in the locality were involuntarily exposed and for their life-time. The permissible level of exposure was accordingly fixed at a lower level for the latter. The Commission was a purely advisory scientific body composed of persons with special experience of radiation problems and with no axe to grind. Its recommendations did not have any legal standing, but were in fact being widely applied. His own country, which had accepted them, would be reluctant to embody them in legislation since the criteria used would inevitably require modification in course of time.

Dr. LOUTIT said that the Commission, which was held in high regard in Canada, the United Kingdom and the United States had originally been set up to frame international standards for laboratories and hospitals using radium. It had now had to extend its field of competence to some hundred radioactive elements. On the basis of the limited data so far available it had issued tentative figures for the permissible concentration of such elements in drinking water and environmental ~~area~~ air. It had not yet been able to consider the wide range of chemical and physical states in which the elements might present themselves.

Dr. CIPRIANI said that it was important to realize that at present the Commission was not strictly international in character because ~~its members were appointed as technical experts~~ persons with special knowledge, and all countries could not to be consulted of

be represented on it, since there were many which had no experience of atomic research.

Its relation to the International Congress of Radiology was not very clearly understood, but his impression was that the link between the two might by force of circumstance become even more tenuous than it had been in the past.

Dr. DOROLLE, Deputy Director-General, observed that although WHO did not have official relations with the International Congress of Radiology, of which the International Commission was theoretically a branch. However, the latter was a founder member of the Council for the Co-ordination of International Congresses of Medical Scientists which received a subsidy from WHO and UNESCO. There would be nothing to prevent WHO from establishing relations with the Commission, should the latter apply for such relations.

The CHAIRMAN observed that there were very definite advantages in the Commission being organized in a relatively modest way and being composed of scientific experts, since its recommendations could have very significant repercussions, since safety standards had an important bearing on the design and cost of plants and operating costs.

Turning to the general problem of waste disposal, he said that so far, very little was known of how to use waste products economically.

Dr. LOUTIT said that the problem with liquid waste was to reduce it to the smallest possible volume by chemical means for storing in containers. Solid waste, such as contaminated laboratory or industrial gear, if of reasonable bulk, could be disposed of at sea, for example far out in the

Atlantic. Such waste could decay on the sea-bed without danger of radiation or contamination ~~of things~~ on the surface. The plutonium factory on the north-west coast of England disposed of much low-activity material ~~by means of~~ through a pipe-line out to sea. The sea-bed and its flora and fauna were under continuous observation. With the volume of waste at present discharged and during the ~~foreseeable~~ near future ~~for that type of waste, this did not present any~~ there was no problem. The situation was more difficult for reactors or establishments which had no direct access to the sea and depended on rivers for disposal. There, stringent control was necessary to prevent any possibility of contaminating drinking water. The waste was subjected to very expensive and lengthy chemical treatment to remove any radioactivity and to ensure that the water at the outlet was drinkable. With fairly fast-running and muddy rivers like the Thames, the river mud was a useful absorbing agent and helped to keep the water purified.

As he had already explained, reactors were at present situated in relatively remote districts in sparsely populated areas. With the development of atomic power, the economic advantage of setting up reactors near points of consumption would inevitably have to be considered and the problem of the disposal of waste, with all its implications for public health, would then become more acute.

Dr. CIPRIANI said that radio active waste was dangerous first because it might cause cancer and secondly because it might give rise to genetic changes. The problem of disposing of radio active material used in laboratories had not been solved as far as his country was concerned and no general instructions on the matter had been issued. The potential dangers when all laboratories throughout the world were in a position to use tracer techniques was alarming.

Some radio active waste remained "alive" for very long periods and it was extremely expensive to construct suitable tanks for storage. At the Chalk River plant certain cooler waste was buried in the soil but it remained to be learnt how to ensure that through ground water streams and rivers were not contaminated.

Professor MANNEBACK said that the possibility of disposing of waste in disused coalpits had been considered in Belgium.

Dr. CIPRIANI observed that two Belgians who had visited Canada had put forward a scheme for the disposal of liquid waste whereby two wells were to be dug some 20 to 30 feet apart and the waste poured into one while the other was continuously pumped. The water in the latter was then to be examined and if found pure it could be assumed that the waste could thus be safely disposed of.

Professor MANNEBACK asked whether any research was being done on transforming waste materials.

Dr. CIPRIANI replied that they could only be returned to the reactor after which they would remain "alive" for a shorter period. Though uses

could be found for waste products, that would only be a ~~palative~~ temporary solution since they would eventually have to be disposed of and any atomic energy plant inevitably was left with some residue materials. He would also like to point out that once radio active materials had left the plant it was not always possible to keep track of them.

The CHAIRMAN said that a great deal of research was being done in the United States on how waste products could be used. If some economic use could be found it might pay for the cost of disposal. Abandoned oil wells had been considered as final depositories for atomic waste as well as deep sea canyons cutting through the continental shelf. If currents in such canyons could be reliably predicted waste could be disposed of closer to the mainland. // The general lines of NP policy for the controlled disposal of waste in rivers was being discussed in the United States with public- health authorities. The effluence into the water was to be kept at below one tenth of the permissible degree of contamination of drinking water.

Water-cooled reactors had given rise to difficulties because they raised the average temperature of a river and thereby destroyed the biological cycles // of fish.

4. REACTOR SAFETY

The CHAIRMAN observed that if reactors were to be built in or near highly populated areas a whole series of problems would arise.

Dr. LOUTIT said that it was impossible to construct an absolutely safe reactor. The installation of safety devices would have to be to some extent governed by economic considerations. The most probable kind of accident in a reactor would be fire resulting in some radio active elements becoming airborne. It was hoped in the United Kingdom to avoid that danger by building reactors with pressure shelves. The ~~chief concern of the United Kingdom~~ authorities were chiefly concerned about the danger to agriculture of such accidents, ~~fissionable products having become volatile at high temperature and ultimately being deposited somewhere.~~

The CHAIRMAN pointed out that the degree of danger from the escape of radio active elements from a reactor depended on the moment in the product ~~process within the plant~~ at which the ~~that~~ escape occurred.

Dr. CIPRIANI said that from the public-health point of view the location of reactors was extremely important. The effects in a reactor meltdown of an accident such as that which had occurred at the Chalk River Plant ~~in a reactor situated in a town~~ would have been very different.

The CHAIRMAN said that the possibility of a device to containing volatile products in the case of accident was being considered in the United States.

Dr. GEAR, Assistant Director-General, Central Technical Services, asked whether such problems would had arisen in the case of small reactors which might interest countries wishing to participate in the international programme.

The CHAIRMAN observed that the problem was one of a degree but it existed for all reactors. Operating personnel must have the same degree of competence whatever the size of the plant. Under the proposed international agency the fuel for reprocessing would be shipped back to the supplying countries.

Dr. GEAR, Assistant Director-General, Central Technical Services, ~~wondered whether~~ stressed that fellows from countries where atomic research was relatively new ~~would be capable of appreciating~~ should be specially instructed in safety problems as a whole and in relation to the ~~whole~~ general question of public health.

The CHAIRMAN pointed out that the projected conference would have to deal with all such questions but countries which were new in the field would still require continuing advice and help.

Dr. DOROLLE, Deputy Director-General, said that it would be WHO's responsibility ~~for~~ to draw the attention of the Advisory Committee to the need for including in the agenda of the conference any item concerning health ~~aspects of~~ hazards resulting from the use of radio active materials. It would obviously be necessary to stress the dangers associated with the operation of reactors. Given ~~the lamentable human failure to learn~~ that men seldom learn from the ~~mistakes of others~~ lessons of the past, WHO as the international health agency ~~must send~~ would send a serious warning about the nature and scope of the dangers associated with the production of atomic energy, so that all countries would realize the need for ensuring safety problems as early as the planning stage

5. DISEASES WHICH MIGHT RESULT FROM UNDUE EXPOSURE TO RADIATION

Dr. LOUTIT said that there was a good deal of medical evidence to show that undue exposure to high levels of radiation either external or internal would bring about an acute clinical manifestation. The chronic effects of radiation at a lower level could produce disorders of the blood-forming tissues. Intermediate chronic exposure in excess of the permissible limit would cause destruction of the marrow. Exposure on the borderline of the permissible dose might result in an increase of leucaemia. ~~There was a strong suspicion that the incidence of leucaemia was increasing in western countries and mainly among professional groups of the population.~~

Local over-radiation for therapeutic purposes increased the probability of malignant growths after 10, 15 or 20 years. Thus the increased use of radio active materials might present a danger to health. It would be extremely valuable to assemble statistics which some 50 years hence might provide data on the effects of atomic energy developments.

Acute over-exposure to radiation of head and eyes particularly to fast neutrons commonly produced cataract. He was unable to provide definite information about the effects of electro-magnetic radiation.

Dr. CIPRIANI said that it was regrettable that data for the past 60 years on the effects of radiation was not available; that lack must be remedied as present information was largely based on animal experiments. It was essential to obtain material for predicting the effects of radiation on human beings.

Dr. DOROLLE, Deputy Director-General, said that such a study would constitute a new branch of epidemiology with its own rules and techniques.

The CHAIRMAN welcomed the broad definition of epidemiology used in WHO.

So far, the only systematic effort to study the effects of radiation had been made by United States and Japanese scientists and doctors on the survivors of the atomic explosions in Nagasaki and Hiroshima. The careful observations made had revealed that 10 per cent. of those who had been within a short distance of the explosion had suffered some degree of lens change. The peak effect had been passed and there was now some regression. The incidence of leukaemia among those exposed to mixed gamma and neutron radiation at a further distance from the explosion had increased 20 to 30 times in comparison to the normal incidence in Japan.

It was impossible to show whether any permanent decline in fertility had occurred among those seriously exposed.

A great effort had been made to evaluate genetic changes, and 55,000 babies conceived after the explosions had been examined and the data compared with that obtained from babies born to parents who had not been exposed to radiation. No significant changes had been detected after the elimination of adventitious variables, though there had been some shift in the sex ratio. There was some evidence that the death rate of persons who had been exposed to radiation was higher than normal.

Dr. CIPRIANI considered ~~observed that~~ it to be paradoxical that no sufficient? effort had been made to protect radiologists, who were continuously exposed to far greater radiation than scientists using radio isotopes. The Commission on Radiological Protection had decided that the situation could only be dealt with by disseminating as widely as possible within the medical profession information on the dangers involved.

The CHAIRMAN said that geneticists were concerned about the effects ~~of the ingestion~~ of fission products, but opinion among them was very much divided and reliable data for making predictions about human beings was lacking, though there was a considerable amount of biological evidence available about the genetic effects of radiation on plants.

Dr. LOUTIT said that it was too early to predict the impact of increased radioactivity on ~~operation~~ population stability.

6. ~~INJURY~~ HAZARDS IN URANIUM MINING

Dr. G[illegible], Assistant Director-General (Central Technical Services), said that in South Africa uranium was a by-product of gold mining and the

only specific hazard was silicosis, which had been ~~nearly~~ almost eliminated by the various measures already adopted to protect the miners.

The CHAIRMAN asked whether the incidence of ~~carcinoma~~ cancer was high in the gold mines.

Dr. GEAR, Assistant Director-General (Central Technical Services), replied that in South Africa labourers never remained long in the gold mines, the maximum being for a period of 18 months to two years. They then returned to their tribal areas and it was therefore difficult to follow up their medical history, though some information could be derived from the records of the Silicosis Bureau at Johannesburg.

The CHAIRMAN said that in ~~re-opening~~ old mines re-opened for the purpose of extracting uranium ores ~~it had been found that~~ (found) radon activity was high. It should be noted that the mines were frequently surrounded by villages.

Prof. MANEBACK said that the uranium ores mined in Katinga in the Belgian Congo were sent ~~in the rough state~~ unrefined to Antwerp. He could not, therefore, give much information on radiation hazards.

Dr. CIPRIANI said that there was some evidence - though not definite - that miners in Czechoslovakia had been stricken by carcinoma as a result of ingestion of alpha particles, dust and radon which tended to be present in high quantities if the mines were not properly ventilated.

In Canada there was no problem at the moment because the uranium mines were situated in the ~~region of the~~ Arctic Circle and miners had no

inducement to stay for long in such remote areas lacking community facilities.

Danger from radon and dust could be greatly diminished with proper ventilation and drilling methods, but if these measures were very expensive.

The CHAIRMAN, in answer to a question by Prof. Manneback, said that it was difficult to draw any definite conclusions from the statistics of carcinoma in mines of Saxony where nickel and cobalt were present as well as radon and dust.

Prof. MANNEBACK said that it was clearly essential to recommend that mines ~~were provided~~ should be with good ventilation and that a close watch ~~were~~ should be kept on the amount of radon present.

The CHAIRMAN observed that such safety measures were costly and were beyond the range of small mine-owners such as those operating mines in Colorado.

Dr. [illegible], Assistant Director-General (Central Technical Services) confirmed that the South African gold-mining industry had invested large sums in special ventilating and drilling systems as well as in medical services and inspection.

The meeting rose at 12.20 p.m.